925,787

# PATENT SPECIFICATION

DRAWINGS ATTACHED

925,787

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COMPLETE SPECIFICATION

## Hydrostatic Regulator

We, HYDREL AKTIENGESELLSCHAFT, a Swiss corporate body, of 14 Badstrasse, Romanshorn, Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

In the control and regulation of hydrostatic drive systems control means are used, for example for the control and regulation of the quantity of liquid flowing or the rate of flow. In such control means the volume of liquid flowing therethrough is dependent not only upon the cross-section, but also upon the pressure difference between the liquid inlet and outlet. In order to minimise the effect of changing pressure it has already been proposed to use control means having two throttles arranged one behind the other, the flow cross-section of one of the throttles being variable with pressure in such a way that the pressure drop at the throttle remains approximately constant.

In one known regulator one throttle, which is pressure-dependent, is constructed as an axially movable two-part piston which is subjected at one end to spring pressure and one of the parts of which regulates the entry of liquid into the regulator. The second throttle is a hand-operated throttle which is provided behind the first mentioned throttle and by means of which the quantity of liquid discharged is controlled. This hand-operated throttle is in the form of a conical valve-member which can be moved towards and away from an annular valve seat, so that the quantity of liquid flowing through is dependent upon the size of the annular gap set between the valve cone and the valve seat.

A disadvantage of this known form of regulator is that the quantity of liquid flowing through is dependent upon the viscosity of the liquid, such as oil. This disadvantage can be avoided by keeping the temperature constant by pre-cooling or pre-heating the oil. However, this requires additional apparatus and involves additional expense. It has also been previously proposed to vary the throttle cross-section in dependence upon varying temperature, for example by using the thermal expansion of solid or liquid bodies to adjust the throttle. However, this also requires additional apparatus and control means and thus causes higher expense and results in a greater liability to breakdowns.

It is an object of the present invention to provide a regulator in which the above-mentioned disadvantages will be eliminated, or at least reduced.

According to the invention, there is provided a regulator for controlling the flow of liquid in a hydrostatic system, the regulator including two variable throttle devices, one of which is variable in response to variation in the liquid pressure in the system and the other of which comprises an obturating disc having a cut-away portion, the disc being rotatable relatively to a liquid-flow opening so as to vary the flow cross-section defined by the cut-away portion and the opening.

The regulator of the invention makes possible continuous regulation of the quantity of liquid flowing, between zero and a maximum value. For this purpose the said other throttle device may be actuated manually or mechanically.

The invention also provides hydrostatic apparatus incorporating regulators of the above-mentioned form.

The invention will now be described more fully with reference to the accompanying drawings which show, by way of example only, one particular form of regulator constructed in accordance therewith. In the drawings:

Figure 1 is a longitudinal section through the regulator, a piston which forms a pressure-

[*Price 4s. 6d.*]

dependent throttle being disposed in one end position in which the flow of the liquid is interrupted;

Figure 2 is a section along the line II—II in Figure 1;

Figure 3 is a longitudinal section through the lower part of the regulator, similar to Figure 1 but showing the pressure-dependent throttle in a position in which it allows the flow of liquid;

Figure 4 is a longitudinal section through the upper part of the regulator, but showing a somewhat modified form of manually operated throttle and

Figure 5 is a plan view of Figure 4 with the housing wall partly cut away.

The regulator includes a housing 1 with an inlet 2 and an outlet 3 for the liquid, the flow of which is to be controlled. In the housing 1 there is provided a chamber 4 connected, on the one hand, with the inlet 2 and, on the other hand, by way of a passage 5 with a further passage 6. In the passage there is an axially movable piston 11 constituting a pressure-dependent throttle. At one end this piston is shaped to form a headpiece 7, the diameter of which is equal to the internal diameter of the passage 6. In the end face of the headpiece 7 there is a depression 8. Between the headpiece 7 and the end of the passage 6 opposite the headpiece there is defined a chamber 9, which communicates with the chamber 4 through a bore 10. Apart from the headpiece 7, the piston 11 has an intermediate diameter portion corresponding in diameter to the diameter of a restricted orifice 12 provided intermediately of the length of the passage 6, and a portion 13 of still smaller diameter. The end portion 14 of the piston opposite to the headpiece 7 is of larger diameter than the portion 13 and fits into a part 6*a* of the passage 6, the diameter of the part 6*a* corresponding to that of the said end portion 14. At the end 14, the piston 11 has a depression 15 in which there is disposed a compression spring 16 which rests with one end on the end of the part 6*a* of the passage 6. The depression 15 is in communication through a bore 17 with the part of the passage 6 beyond the orifice 12. The outlet of the bore 17 is situated at a point between the orifice 12 and the headpiece 7 so that despite axial displacement of the piston there is always a connection between the passage 5 and the bore 17.

In the chamber 4 there is a manually operable throttle which is constituted by a disc 18 which is rotatable relatively to the passage 5, and which has a cut-away portion 19. The disc 18 is secured to a spindle 20 which carries a knob 21 on the end which projects from the housing 1. Thus the disc 18 can be rotated relatively to the passage 5 in such fashion that the quantity of liquid issuing from the chamber 4 through the passage 5 and into the passage 6 can be regulated continuously between zero and a maximum value determined by the diameter of the passage 5.

The manner of operation of the regulator is as follows:

Liquid, for example oil, passes through the inlet 2 into the chamber 4. If the passage 5 is closed by the disc 18, the piston 11 will be situated in the end position illustrated in Figure 1, because liquid flows through the bore 10 into the chamber 9 and the liquid pressure effects the movement of the piston 11 into this position against the pressure of the spring 16. In this position the piston 11 closes the orifice 12 and interrupts the connection between the passage 5 and the outlet 3. However, when the disc 18 is rotated into the position in which the cut-away portion 19 is situated over the passage 5, liquid has access to the passage 6 and thence, by way of the bore 17, to the depression 15 in the piston end 14. With the co-operation of the spring 16 the piston 11 carries out an axial movement in the direction to reduce the volume of the chamber 9, so that the intermediate diameter portion of the piston 11 is disengaged from the orifice 12 and liquid can flow through the annular gap defined between the small diameter portion 13 and the orifice 12 and thence to the outlet 3. By rotation of the disc 18 in one or other direction, as shown by the arrows in Figure 2, a smaller or larger part of the passage 5 will be uncovered and thus the quantity of liquid flowing therethrough can be regulated continuously.

Apart from the cross-section available for the flow of liquid between the chamber 4 and the passage 5, the quantity of liquid flowing is also dependent upon the pressure difference between the inlet and the outlet. The arrangement of the two throttles one after the other renders it possible to minimise the effect of change in pressure and to maintain a constant pressure difference between the inlet and the outlet. It has been found that as a result of the construction of the manually operated throttle as a disc with a cut-away portion, the passage of the liquid takes place by the shortest path, so that not only can the frictional resistances be kept small, but also the effect of viscosity is reduced to an extent which cannot be achieved in known regulators having conical throttling elements.

In using the regulator of the invention in practical hydrostatic drive systems, for the solution of specific control problems, it has been found that it is often expedient to permit the passage through the passage 5 of a quantity of liquid lying between a maximum upper limiting value and a lower but variable limiting value. Such conditions are required for example in the control of machine tools, where the setting and withdrawal of machine tables or tool holders has to take place at high-speed, while the advance of the tool during the machining operation has to take place

with a reduced speed adapted to the tool being used in any particular case.

In order to render this possible the regulator described above may be modified in the manner shown in Figures 4 and 5. In this case the manual operation spindle 20 of the throttle disc 18 is axially movable and carries a stop collar 22 on which there bears one end of a helical spring 23 which is engaged on the spindle and is tensioned between the housing 1 and the stop 22. On the outside of the housing 1 a lever 25 is pivotally mounted at 24 and serves as a retaining element for the knob 21, when the latter has been lifted away from the housing, the disc 18 being correspondingly lifted away from the bottom of the chamber 4 and held in the position shown in dot-and-dash lines. In order to retain the knob 21 and disc 18 in this position, the lever 25 is pivoted in the direction of the arrow shown in Figure 5 and moved beneath the knob. A longitudinally movable lever or other retaining means could be used in place of the pivotable lever 25.

When opening the passage 5 by lifting away the disc 18 from the bottom of the chamber 4 in this way, the spring 23 is tensioned and, upon release of the knob 21, it automatically pushes the disc 18 back to its initial position, without variation of the rotational position of the disc taking place. Thus the lower limiting value set in each case for the quantity of liquid flowing can be retained without change, as long as is necessary for effecting the desired controlling action.

The thickness of the retaining element 24 used in any particular case determines the distance at which the underneath surface of the disc 18 is spaced from the bottom of the chamber 4 when the securing element is situated in its operative position. When it is desired to make this distance smaller or larger as may be necessary within the range possible, there can also be used as a retaining element, a lever which is wedge-shaped, that is to say, the surface remote from the housing is inclined, or it may be stepped. The distance between the surface of the disc and the bottom of the chamber is then dependent upon the position of the retaining element in relation to the knob 21 in its operative position.

In the form of controller described, the manually operated throttle can also be replaced by one which is operable mechanically through a linkage, a cam or other known means. The aperture through which the passage 5 opens into the chamber 4 and which is controlled by the rotatable disc 18 can also be flared conically towards the bore 6, in order to provide a sharp-edged orifice and thus to reduce the effect which friction has on the liquid entering the passage 5.

WHAT WE CLAIM IS:—

1. A regulator for controlling the flow of liquid in a hydrostatic system, the regulator including two variable throttle devices, one of which is variable in response to variation in the liquid pressure in the system and the other of which comprises an obturating disc having a cut-away portion, the disc being rotatable relatively to a liquid-flow opening so as to vary the flow cross-section defined by the cut-away portion and the opening.

2. A regulator according to claim 1, wherein the disc is mounted for axial movement towards and away from the opening whereby, by moving the disc into a position in which it is displaced from the opening, it can be temporarily rendered at least partly ineffective without varying the angular position of the disc relatively to the opening.

3. A regulator according to claim 2, including means to retain the disc in its displaced position.

4. A regulator according to claim 3, wherein the retaining means are adapted to retain the disc displaced at different distances from the opening.

5. A regulator according to claim 3 or claim 4, wherein the disc is carried by an axially displaceable shaft, the retaining means comprising a lever which is pivotable into and out of a position for engagement between a member carried by the shaft, externally of a casing of the regulator, and the casing-wall, thereby to retain the shaft and the disc in a displaced position relatively to the casing-wall.

6. A regulator according to claims 4 and 5, wherein the lever is wedge-shaped so as to allow the shaft and the disc to be retained in different displaced positions relatively to the casing-wall.

7. A regulator according to any one of the preceding claims, wherein the throttle devices are so arranged that the said other device controls the supply of liquid to the throttle opening of the said one device.

8. A regulator for controlling the flow of liquid in a hydrostatic system, substantially as herein described with reference to and as shown in the accompanying drawings.

9. A hydrostatic system, including a liquid-flow regulator according to any one of the preceding claims.

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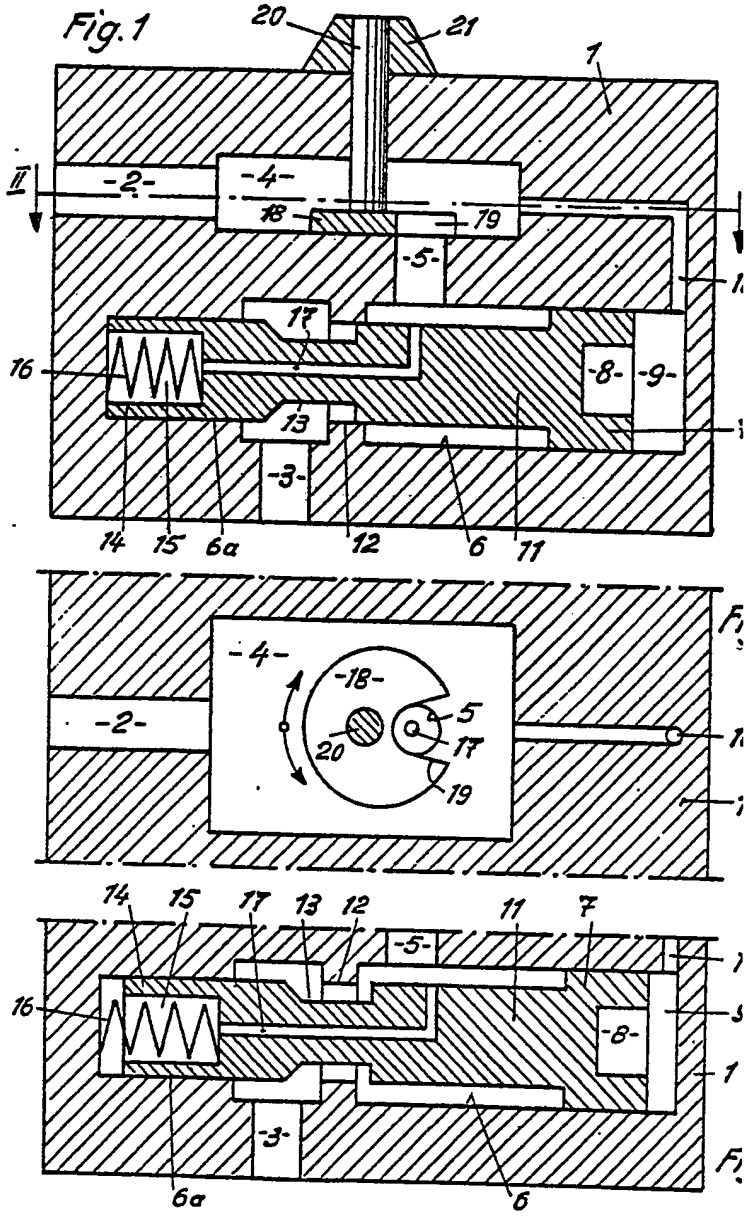
Fig. 1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Sheets 1 & 2

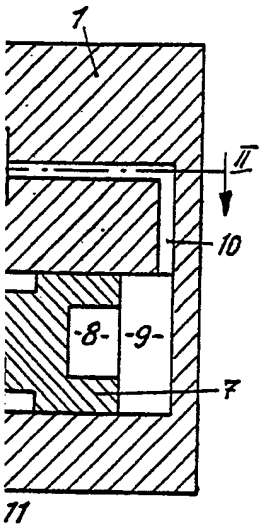
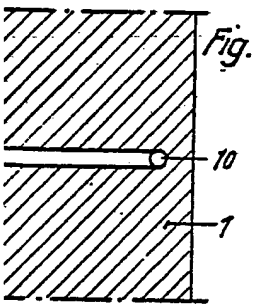



Fig. 2



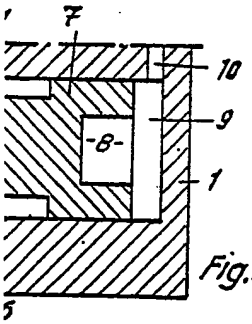




Fig. 3

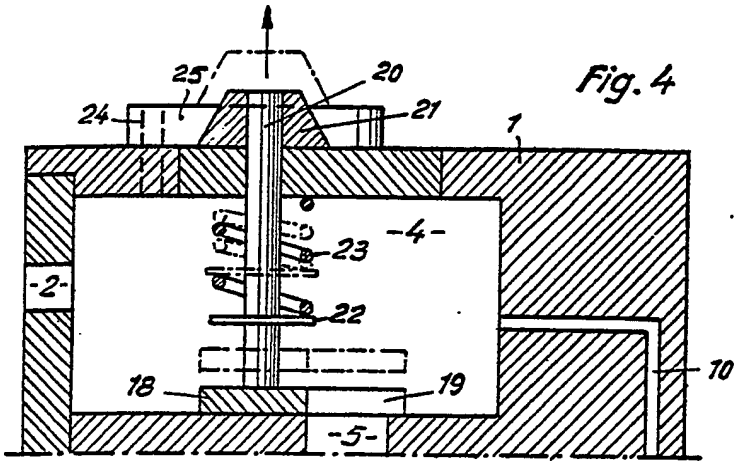



Fig. 4

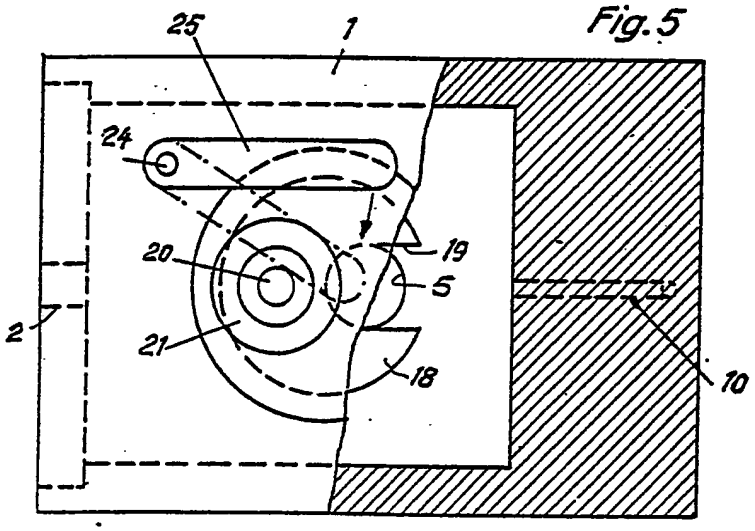



Fig. 5

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